Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

DIVERSION

CODE 362

(ft)

DEFINITION

A channel generally constructed across the slope with a supporting ridge on the lower side.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Break up concentrations of water on long slopes, on undulating land surfaces and on land that is generally considered too flat or irregular for terracing
- Divert water away from farmsteads, agricultural waste systems, and other improvements
- Collect or direct water for storage, water-spreading, or water-harvesting systems
- Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above
- Intercept surface and shallow subsurface flow
- Reduce runoff damages from upland runoff
- Reduce erosion and runoff on urban or developing areas and at construction or mining sites
- Divert water away from active gullies or critically eroding areas
- Supplement water management on conservation cropping or stripcropping systems

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where surface runoff water control and management are needed, and where soils and topography are such that the diversion can be constructed and a suitable outlet is available or can be provided.

CRITERIA

General Criteria Applicable to All Purposes

Capacity

Diversions as temporary measures, with an expected life-span of less than 2 years, will be designed for a minimum capacity for the peak discharge from the 2-year frequency, 24-hour-duration storm.

Diversions that protect agricultural land must have a minimum capacity for the peak discharge from a 10-year frequency, 24-hour-duration storm.

Diversions designed to protect areas such as urban areas, buildings, roads, and animal waste management systems require a minimum capacity for the peak discharge from a storm frequency consistent with the hazard involved but not less than a 25-year frequency, 24-hour-duration storm. Freeboard minimum depth is 0.3 ft.

Design depth is the channel storm-flow depth plus freeboard.

Cross Section
The channel may be parabolic, V-shaped, or trapezoidal. The diversion side slopes are based on stability and access requirements for maintenance.

The minimum top width of the supporting ridge is 4 feet **except** for diversions with less than 10 acres of drainage area above cropland, pastureland, or woodland, where the minimum top width of the supporting ridge may be 3 feet.

The top of the constructed ridge at any point must not be lower than the design depth plus the specified overfill for settlement. The ridge height shall include an adequate settlement factor. This may range from 5% for very well compacted fills to 15% or more for push-up type construction.

The diversion design depth at a culvert crossing must equal the headwater depth for the culvert design storm plus freeboard.

The front and cut slopes for permanent diversions should not be steeper than 3:1 for maintenance purposes and preferably 4:1. The back slope of the ridge is not to be steeper than 2:1 and preferably 4:1. For temporary diversions, the side slopes should not be steeper than 1:1 under any conditions.

Farmed diversions should have front slopes, back slopes, and cut slopes which are 5:1 or flatter. The front slope and back slope must be constructed to fit the farm equipment being used. The cut slope length will vary with the land slope and amount of cut; it also should be built to accommodate farm equipment.

Channel Stability and Capacity
Channel grades may be uniform or variable. Determine minimum depth and width requirements for channel stability by using the procedures in the National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 9, Diversions; or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-Lined Open Channels (Sept. 1987); or other equivalent methods. The ARS handbook can be found on the USDA National Agricultural Library Digital Collections Web site.

When a retardance class method is used to determine capacity (Q) of the diversion by the relationship

$$Q=AV,$$

and, the velocity (V) is calculated by using Manning's Equation; use the highest expected value of Manning's "n", which represents the flow retardance due to the height, density and type of vegetation.

Location
The outlet conditions, topography, land use, cultural operations, cultural resources, and soil type shall determine the location of the diversion.

Grade and Velocity
Channel grades may be uniform or variable. If allowable velocity is used for the design procedure, the channel velocity shall not exceed that considered nonerosive for the soil and the planned vegetation or lining.

Where diversion channels are grassed, use "C" retardance or less to determine velocity. Maximum velocities shall not exceed those in Table 1. Where diversion channels are farmed, velocity will be determined using Manning's n = 0.035 or less.

Protection Against Sedimentation
Diversions normally should not be used below high sediment-producing areas. When they are, a practice or combination of practices for the drainage area are needed to prevent damaging accumulations of sediment in the channel. This may include practices such as land treatment erosion control practices,

cultural or tillage practices, vegetated filter strip, or structural measures. Install needed sediment control practices in conjunction with or before the diversion construction.

If movement of sediment into the channel is a problem, include extra capacity for sediment accumulation in the design and instructions for periodic removal in the operation and maintenance plan.

Outlets

Each diversion must have a safe and stable outlet with adequate capacity. The outlet may be a grassed waterway, a lined waterway, vegetated or paved area, a grade stabilization structure, an underground outlet, a stable watercourse, a sediment basin, or a combination of these practices. The outlet must convey runoff to a point where outflow will not cause damage. Install vegetative outlets before diversion construction to insure establishment of stable vegetative cover in the outlet channel.

When using an underground outlet, the diversion ridge must contain the design storm runoff combined with an underground outlet release rate to protect from overtopping. To prevent the diversion from overtopping, the designed outflow capacity of the outlet(s) must be achieved at, or below, the design depth of the diversion at their junction.

Vegetative Establishment

Vegetate diversions according to NRCS Conservation Practice Standard (CPS) Critical Area Planting (Code 342). Select species suited to the site conditions and intended uses. Use plant species that exhibit the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the diversion.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, fabric checks, filter fences, or runoff diversion to protect the vegetation until it is established. Planting of a close-growing crop, (e.g., small grains or millet), on the contributing watershed prior to construction of the diversion can significantly reduce the flow through the diversion during establishment.

Lining

If the soils or climatic conditions preclude the use of vegetation for erosion protection, nonvegetative linings such as concrete, gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used.

Design diversion channel liners in accordance with CPS Lined Waterway or Outlet (Code 468).

CONSIDERATIONS

A diversion in a cultivated field should be aligned and spaced from other structures or practices to permit use of modern farming equipment. The side slope lengths should be sized to fit equipment widths when cropped.

At noncropland sites, consider planting native vegetation in areas disturbed due to the diversion construction.

Diversion of upland water to prevent entry into a wetland may convert a wetland by changing the hydrology. In analyzing downslope impacts, minimize adverse effects to existing wetland functions and values. Similarly consider how to maximize wetland functions and values with the diversion design.

Provide construction inspection to ensure that the top of the constructed ridge at any point meets the design depth plus the specified overfill for settlement.

Any construction activities should minimize disturbance to wildlife habitat. Opportunities should be explored to restore and improve wildlife habitat, including habitat for threatened, endangered, and other species of concern.

For vegetated diversions, avoid areas where unsuitable subsurface, subsoil, substratum material that limits plant growth such as salts, acidity, root restrictions, etc., may be exposed during implementation of the practice. Where these areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible, consider stock piling the topsoil, over excavating the diversion and replace the topsoil over the excavated area to facilitate vegetative establishment.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for diversions that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications must include—

- A plan view of the layout of the diversion.
- Typical cross sections of the diversion(s).
- Profile(s) of the diversion(s) that include both the channel bottom and supporting ridge top.
- Disposal requirements for excess soil material.
- Site specific construction specifications that describe the installation of the diversion. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for use by the client. Include specific instructions for maintaining diversion capacity, storage of runoff water, ridge height, and outlets in the plan.

The minimum requirements to be addressed in the operation and maintenance plan are—

- Provide periodic inspections, especially immediately following significant storms.
- Promptly repair or replace damaged components of the diversion as necessary.
- Maintain diversion capacity, ridge height, and outlet elevations especially if high sediment-yielding regions are in the drainage area above the diversion. Establish necessary clean-out requirements.
- Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is at the lowest point. Inlets damaged by farm machinery must be replaced or repaired immediately.
- Redistribute sediment as necessary to maintain the capacity of the diversion.
- Maintain vegetation and trees and control brush by hand, chemical, and mechanical means. Maintenance of vegetation will be scheduled outside of the primary nesting season for grassland birds.
- Control pests that will interfere with the timely establishment of vegetation.
- Keep machinery away from steep-sloped ridges. Keep equipment operators informed of all potential hazards.

REFERENCES

USDA, ARS. 1987. Stability design of grass-lined open channels. Agriculture Handbook 667.

USDA, NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chap. 9, Diversions.

Table 1. Maximum Permissible Velocities for Diversions

			Channel Vegetation Condition		
Soil Texture	Bare channel ft/sec	Retardance	Poor ft/sec	Fair ft/sec	Good ft/sec
Sand, silt, sandy loam, silty loam	1.5	B	2.0	3.0	4.0
		C	1.5	2.5	3.5
		D	1.5	2.0	3.0
Silty clay loam and sandy clay loam	2.0	B	3.0	4.0	5.0
		C	2.5	3.5	5.0
		D	2.0	3.0	4.0
Clay	2.5	B	3.5	5.0	6.0
		C	3.0	4.5	5.5
		D	2.5	4.0	5.0
Coarse gravel	5.0	B, C, or D	5.0	6.0	7.0
Cobbles and shale	6.0	B, C, or D	6.0	7.0	8.0

The choice of retardance B, C, or D will depend on the vegetation and maintenance planned for the diversion channel. Refer to Refer to Table 9-7 on page 9-13 in Chapter 9, Diversions, in the Engineering Field Handbook to select vegetal retardance.